

TCA metric #1

**TCA and *fair* execution.
The metrics that the FX industry must use.**

An analysis and comparison of common FX execution quality metrics between 'last look' vs firm liquidity *and* its financial consequences.

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Part I (i): Applying standard metrics to a sample data set

(i) Fill ratio/rejects

Fill ratio is usually expressed as the percentage of orders that have been filled as a fraction of the total number of those sent to a liquidity provider. This has the virtue of being easy to compute and understand. The higher the fill ratio - the better, as a reject will normally result either in a missed opportunity to trade or in a worse price if the order is later resubmitted to the same (or different) venue.

Although fill ratios are commonly used to compare execution in a commercial setting, the method by which the reject rate is converted into a cost per trade is often not clear. One method is to use a subsequent fill for a rejected order (either from the same or a different LP) to determine the opportunity cost of a reject [2]. This also requires an accurate measure of hold time. The strategy in use may also influence whether a higher rate of fast rejects with a lower opportunity cost per event is preferable to a lower rate of rejects with a longer hold time and potentially higher opportunity cost per reject.

For a quoted price stream from a single LP, the fill ratio should just be a measure of whether the deal was done at the agreed price or not - was the order filled or rejected (or requested). Rejects (errors aside) are due to insufficient liquidity to match the trader's order or LP optionality.

We have calculated fill ratio as the number of orders receiving a fill, divided by the total number of orders (excluding errors). This has some shortcomings in that it does not discriminate between large and small orders nor does it adequately represent partial fills. We have compared the results using a more proportionate calculation of notional value traded divided by notional value ordered, but as this does not materially affect the findings we have opted for the simpler fill and order counts as this is the method we see used by the majority of LMAX Exchange customers.

Causes of rejects

Rejects often include a reason for the reject, and during this analysis we considered using this message field to understand the reason behind a reject with the aim of detecting the exercise of optionality as opposed to other causes such as lack of liquidity.

Order type	Errors	Non error rejects	Total
Market	99	10,480	10,579
Limit	709	36,479	37,188
Previously Quoted (PQ)	52	17,311	17,363
Total	860	64,270	65,130

Table 1: Rejects classified by reason

However, in practice this is not a reliable technique. Messages are not standardised across venues and some can be quite ambiguous in their meaning, covering a wide variety of potential causes. There was only one exception to this - client error messages.

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The clearly identifiable types of error messages seen in the data included: coding or message format errors with the FIX order stream, trading being attempted outside of market hours, the trader exceeding their position limits, having insufficient funds or failing some other pre-trade risk control or exposure tests. Error messages normally are very specific as it is in the interests of all LPs to clearly indicate a problem that requires correction by the trader.

These error rejects were discarded from the fill ratio analysis as they are caused by errors over which neither the venues nor LPs have control. There is one exception - for the analysis of execution latency they do have a particular use, which we cover in the 'Hold time and execution latency' section (p. 29). Error messages in the TPA data are dominated by rejects due to credit issues.

Reject rates by venue

We will first look at reject rates for market orders only. Market orders have no price restriction and we expect a high fill ratio (theoretically 100%) from all venues once errors are excluded. Rejection reasons should relate purely to liquidity or optionality and by excluding limit orders, we can exclude cancels and rejects due to conditions on limit orders that are never met. We further exclude all fill or kill (FoK) market orders to ensure there are no rejects based on any size constraints.

Once all the variability from restrictions on matching is removed we should be left with the underlying best case fill ratios for each venue allowing a direct comparison of each venue's ability to fill trades. The only remaining causes for rejections should then be if there is zero useful liquidity on the book or if a reject happens due to last look optionality.

Venue	Filled	Non error rejects	Fill ratio
Non Bank 2	267,304	43	99.98%
LMAX Exchange	299,085	182	99.94%
Bank 1	207,157	130	99.94%
Bank 2	100,730	372	99.63%
Bank 3	173,571	3,047	98.27%
Non Bank 3	120,789	2,233	98.18%
Non Bank 1	115,823	3,648	96.95%

Table 2: Market order fill ratio by venue

The firm liquidity venue - LMAX Exchange - is near the top of the table, and there is a clear grouping with the top 3 having a better than 99.9% fill ratio and the rest clustered at 99.5% and below. Detailed investigation of the rejects for LMAX Exchange shows that they are all liquidity based rejects related to times when market conditions did not permit orderly execution. In common with some other venues LMAX Exchange includes a variety of protections against off-market trade execution arising from either errors during order submission ('fat finger') or discontinuities in the market price. Market discontinuities commonly occur immediately after market open and are analogous to the 'uncrossing period' seen on equities exchanges.

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This grouping implies a difference in execution model between the top three and the bottom four LPs. The presence of both Bank and Non Bank LPs in the bottom four (assuming the bottom two are not chronically short of liquidity) suggests that rejects due to last look optionality are common to both types of LP.

The next comparison is to look at orders with price restrictions. Some venues implement these as limit orders with a threshold price and some as the ‘previously quoted’ or PQ order type, where a specific price is referenced via a quote id. These price constrained orders are more representative of the majority of institutional trading.

Venue	Order type	Filled	Non error rejects	Fill ratio
Bank 2	PQ	621,250	1,222	99.80%
Bank 1	PQ	1,111,524	3,221	99.71%
Non Bank 3	Limit	768,467	4,190	99.46%
Non Bank 2	PQ	1,431,232	12,868	99.11%
Bank 3	Limit	964,857	14,391	98.53%
Non Bank 1	Limit	613,020	15,828	97.48%
LMAX Exchange	Limit	23,841	2,070	92.01%

Table 3: Limit order fill ratio by venue

This result shows a completely different picture. Looking at the firm liquidity LP, the LMAX Exchange fill ratio is now the lowest whereas for market orders it was near the top of the table. Another surprise is that for some of the bottom four in the market order fill ratio rankings the fill ratio for limits or PQ orders are higher than they are for market orders.

Detailed investigation of the LMAX Exchange rejects using FIX logs and internal tooling shows that 7% of the 2,070 rejects recorded for this set of trades were caused by market conditions that did not allow for orderly execution of risk for general trading (as described above), with the remaining 93% being order cancels. Of the cancels, 1.4% were due to insufficient quantity being available at the price point requested combined with a FoK strategy, and the remaining 98.6% were a limit price miss - i.e. the market had moved away from the limit price specified. **In other words, almost all the LMAX Exchange ‘rejects’ were driven by pricing behaviour on the venue.**

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As the number of limit order trades from this source is relatively small, we examined the limit order fill ratio for both the TPA and a variety of similar LMAX Exchange customers to see if this was an outlier.

Customer	Orders	Fill ratio
A	75,950	85.86%
B	136,872	91.24%
C	76,924	92.55%
TPA	24,910	92.58%
D	70,918	93.99%
E	4,378	95.34%

Table 4: Limit order fill ratio by client

The limit order fill ratio is consistent between the TPA data set and the LMAX Exchange internal view of the fill ratio, as expected. Furthermore the limit fill ratio for the TPA lies within a range of fill ratios for other similar customers and is not an outlier. It is notable that other customers using exactly the same order types (and to the best of our knowledge a comparable trading strategy) are able to achieve a higher fill ratio using the same market data.

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(i) Section summary: fill ratio/rejects

As expected, the order count fill ratio tells us that fill ratios on LMAX Exchange and 2 other LPs are close to 100% for market orders - barring those times when market discontinuities made it unsafe to trade. For price constrained order types - limit and PQ in this data set - the fill ratio for LMAX Exchange is much lower than the last look liquidity providers, with almost all the limit order 'rejects' being cancels due to a missed limit price. This implies that there is something specific about LMAX Exchange liquidity which makes it relatively hard to trade successfully with a high fill ratio using immediate execution limit orders. *(We will return to this in Part II).*

Metrics scorecard

- **Market order fill ratio.** LMAX Exchange is in the top three, but each of the Bank and Non Bank venues have members in the top, medium and low thirds of the table giving both of them medium scores.
- **Limit/PQ order fill ratio.** This is influenced by the two different types of order, with PQ having higher fill rates. Due to this, the Banks earn top marks, Non Banks come second, and LMAX Exchange trails in last.

Metric	Bank 'last look'	Non Bank 'last look'	LMAX Exchange
Market order fill ratio	2	2	3
Limit order fill ratio	3	2	1

Table 5: Fill ratio 'scorecard' points (higher is better)

Box 2 Analysis of fill ratios

The fill ratios on firm liquidity differ significantly for market and limit orders:

- Market order fill ratios are close to 100% on firm liquidity, as expected;
- Limit order fill ratios are much lower, with almost all the limit order 'rejects' being cancels due to a missed limit price.

The lower fill ratios for limit orders on LMAX Exchange imply that there is something specific about this type of liquidity, the trading strategy, or both (see Part II) which makes it relatively hard to achieve a high fill ratio.

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